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RE-USE OF TWO BY-PRODUCTS, WASTEWATER AND FLYASH WITH LOW DOSE OF INORGANIC FERTILIZERS FOR THE CULTIVATION OF FENUGREEK (*TRIGONELLA FOENUM-GRAECUM* LINN.)

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ABSTRACT

Pot experiment was carried out to study the use of urban wastewater and flyash, to reduce the use of NPK fertilizers while growing fenugreek (*Trigonellafoenum-graecum* Linn.). The growth and the yield were enhanced with wastewater and flyash application. Two doses of flyash @ 5 and 10 t/ha were supplemented with urban wastewater, while N@ 10 and 20 kg/ha, P @ 15 and 30 kg/ha, and K @ 10 and 20 kg/ha was also applied. NPK @ 10, 15 and 10 kg/ha respectively amended with flyash @ 10 t/ha along with wastewater proved more effective proving optimum for plant growth, yield and the physiological parameters studied as compared to control (groundwater). Wastewater was superior at all the six sampling stages. Plants (leaves) were also analyzed for two heavy metals chromium and lead as these heavy metals are present in high concentration in this wastewater. However both were present within the permissible limits in the leaves. Therefore, it may be concluded that methi can be grown with low dose of NPK if amended with wastewater and flyash and this can be an option for the reuse of these two by-products.

KEYWORDS: Flyash, Wastewater, Methi, Nitrogen, Phosphorus, Potassium

INTRODUCTION

Agricultural lands amended with municipal wastewater and flyash application can be a way to return the organic matter and essential elements to soil with minimize the risk of environmental pollution and solving the problem of disposal of both liquid and solid waste due to generated in huge amount in Aligarh. Aligarh is famous industrial city, discharge large amount of wastewater while a major quantity of coal is used in power plant for electricity generation, also discharge flyash in large amounts, so due to continuous production of both industrial by-products, this affects the soil, water and air environment along with human health. But now-a-days both wastes are not only wastes, but they are useful products significantly used for recycling of essential elements in soil. Various old and recent studies have shown that there may be improvement in soil fertility using a variety of wastewater and flyash (Ogwueleka 2009). Therefore, it was decided to use a balanced dose of NPK fertilizers with appropriate quantity of flyash and wastewater in Aligarh. Methi being a popular vegetable and also methi seeds have medicinal value, it was selected for the study and being a leguminous crop it was also kept in mind, if, the application of nitrogen and phosphorus, potassium may be supplemented with wastewater and flyash.

METHODS AND MATERIALS

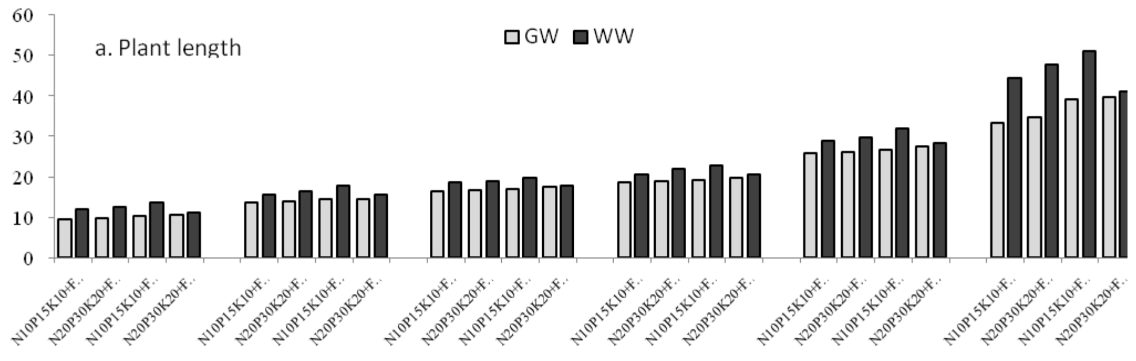
A pot experiment was conducted during 2012-2013 at Botany department, Aligarh Muslim University on fenugreek (*Trigonellafoenumgraecum*)supplemented with two by-products wastewater (WW) and flyash (FA). The vegetable was sown on 20 october in 12" diameter earthen pots. Pots were watered with groundwater and wastewater

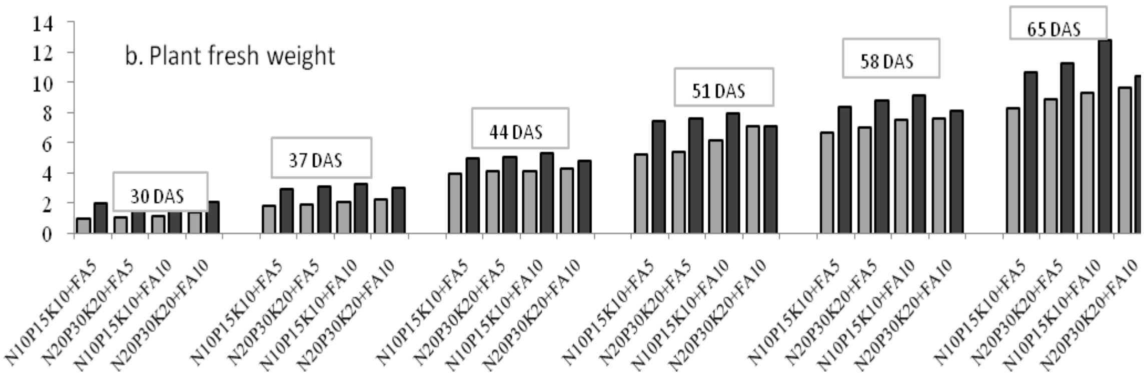
of sewage and industrial wastewater from Aligarh City. Flyash was collected from Harduaganj power plant. Pots were supplemented with 4 combination of nitrogen (N), phosphorus (P) and potassium (K) of NPK as N10 OR 20 P15 or 30 and K 10 or 20 with GW and WW. Flyash was supplemented @ 5 and 10 t/ha. There were eight treatments, each treatments replicated thrice. All cultural practices like pot filling, thinning and weeding were done according to recommendations.Sampling was done at six stages i,e at 30, 37, 44, 51, 58 and 65 days after sowing (DAS). Nitrogen was in the form of urea, phosphorus and potassium as superphosphate and muriate of potash was applied respectively.

Seeds were sown at the rate of 10 seeds/pot to avoid germination failure. Random sampling was done and plants were left for harvesting and calculating yield. Methi was irrigated with ground water against wastewater. Leaf samples were prepared in laboratory, where they were washed, cut in to small pieces, air dried for two days and finally dried at 100 $\pm$1°C in an oven for 72 hours. The samples were ground in warm condition and passed through 1mm sieve. Samples were analyzed for two heavy metals chromium and lead, as the concentration of these heavy metals is more in wastewater in Aligarh city. The metal analysis was done by AAS (Atomic Absorption Spectrophotometer).

RESULTS AND DISCUSSIONS

Plant length, fresh weight and dry weight of plant was enhanced by treatment $N_{10}P_{15}K_{10}FA_{10}$WW as compared to control $N_{10}P_{15}K_{10}FA_0$GW in all stages (Figure 1, a, b, c). Leaf number and leaf area show slightly different results. Treatments $N_{20}P_{30}K_{20}FA_5$WW give more percent increase at 30, 37 and 44 days after sowing followed by other treatments. For other growth stages treatment $N_{10}P_{15}K_{10}FA_{10}$WW was again better (Figure 1,d& 2,e). Leaf number and leaf area was also significantly increased with the combination of WW and FA. Treatment $N_{20}P_{30}K_{20}FA_5$ was followed by treatment $N_{10}P_{15}K_{10}FA_{10}$ giving 83.33% and 77.78% increase at 30 DAS and leaf area gave the similar results at 30 DAS. Treatment $N_{20}P_{30}K_{20}FA_5$WW was followed by $N_{10}P_{15}K_{10}FA_{10}$ giving 56.25% and 48.53% increase at 30 DAS. Rest of the stages and treatment scheme show similar results.Treatment $N_{10}P_{15}K_{10}FA_{10}$WW with highest percentage at all the stages as compared to control $N_{10}P_{15}K_{10}FA_{10}$GW or with $N_{20}P_{30}K_{20}FA_{10}$GW.It showing the application of WW in using the low dose of fertilizers.





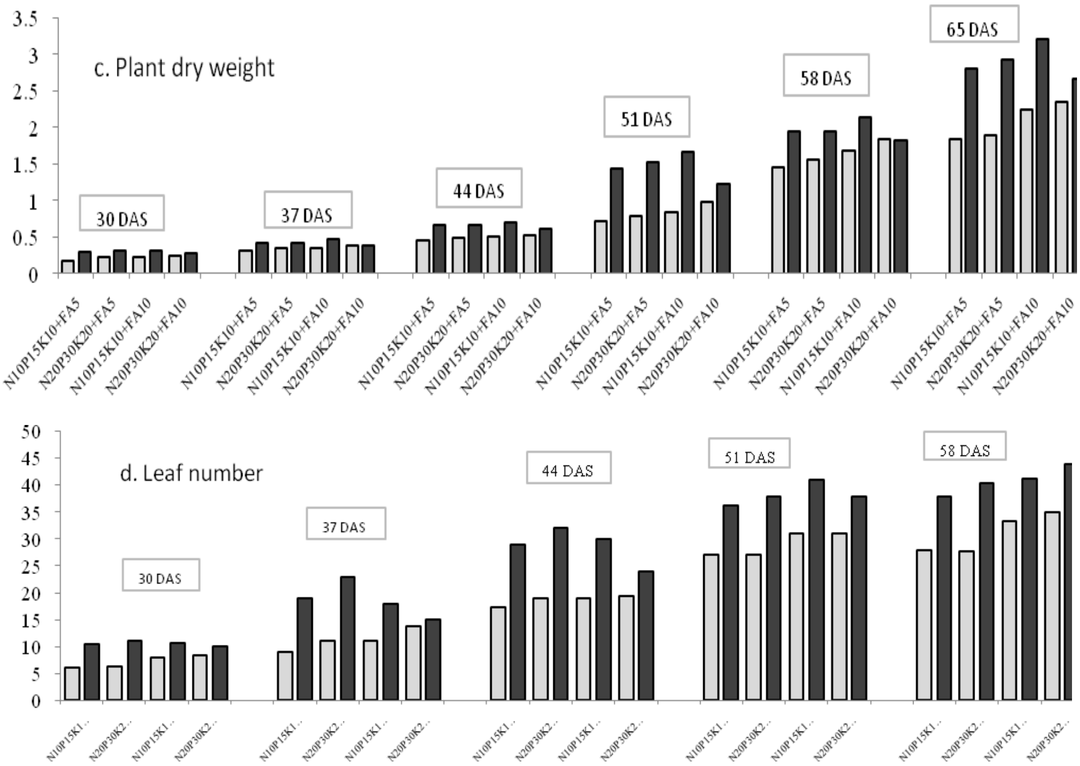
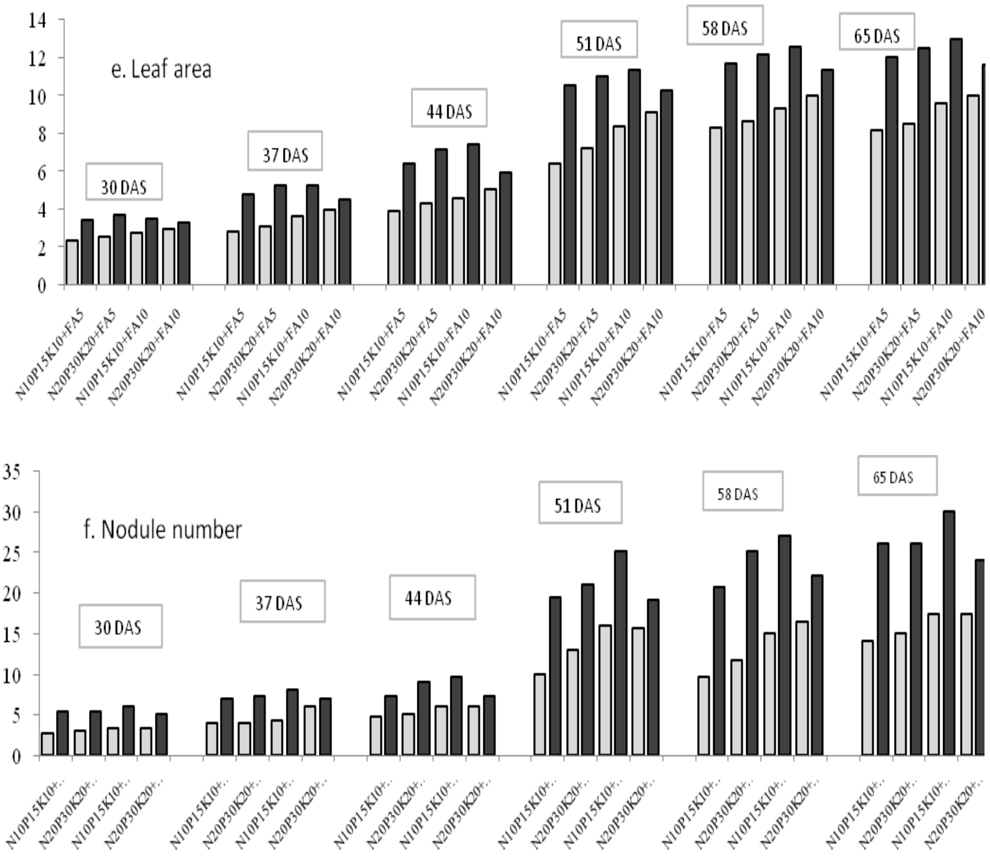


Figure 1: Effect of Flyash and NPK Fertilizers on Plant Length, Freshweight (g), Dry Weight (g) and Leaf Number of *Trigonellafoenumgraecum* Linn. Under the Comparison of Groundwater (GW) and Wastewater (WW) Irrigation



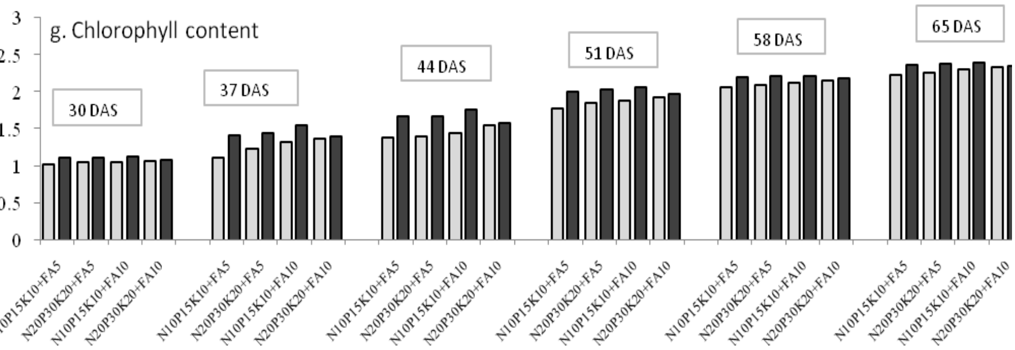


Figure 2: Effect of Flyash and NPK Fertilizers on Leaf Area (cm^2), Nodule Number Andtotal Chlorophyll Content (mg/kg Fresh Weight) of *Trigonellafoenumgraecum* Linn. Under the Comparison of Groundwater (GW) and Wastewater (WW) Irrigation

Nodule number is an important parameter in leguminous crops. It was also observed that treatment $N_{10}P_{15}K_{10}FA_{10}$WW gave highest percent increase in all thegrowing stages (Figure 2,f) also chlorophyll content in same manner with the highest increase with $N_{10}P_{15}K_{10}FA_{10}$WW at all the sampling stages (Figure 2,g).

Regarding the yield parameters like number of seeds, pods per plant, as well as 100 seed weight even considering the pod length and protein content, treatment $N_{10}P_{15}K_{10}FA_{10}$WW show better performance over control GW for all characteristics and at all growing stages (Figure 3, h).

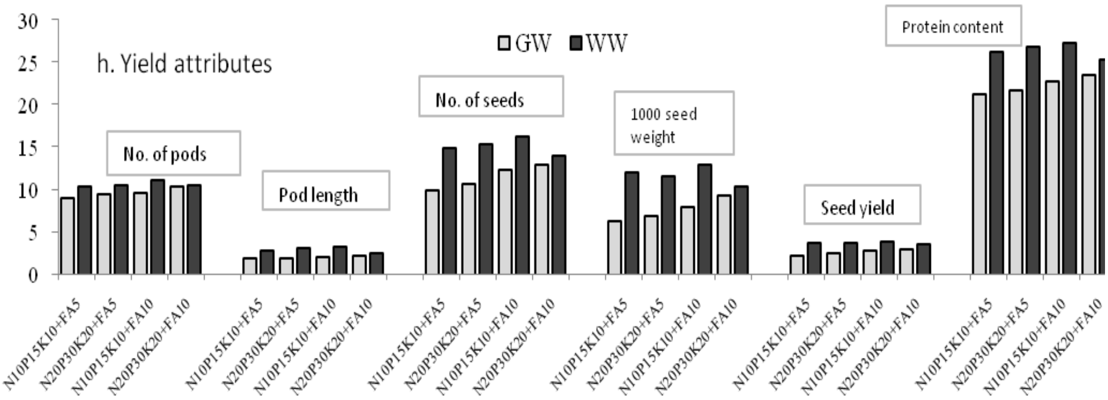


Figure 3: Effect of Flyash and NPK Fertilizers on Yield and Yield Attributes of *Trigonellafoenumgraecum* Linn. Under the Comparison of Groundwater (GW) and Wastewater (WW) Irrigation

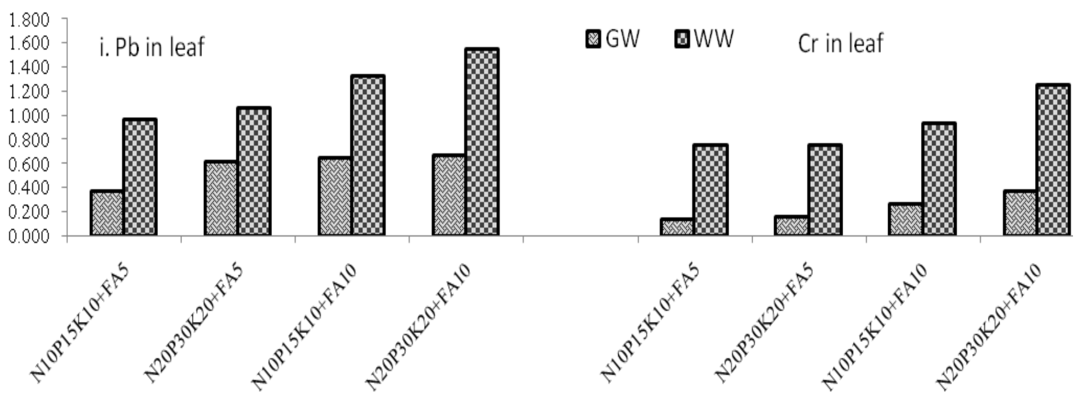


Figure 4: Effect of Flyash and NPK Fertilizers on Leaf Lead (Pb) and Copper (Cu) Content (mg/kg DW) of *Trigonella foenum graecum* L. under the Comparison of Groundwater (GW) and Wastewater (WW) Irrigation

In this study it was also kept in mind whether heavy metals especially lead and chromium which are present in this sewage and industrial wastewater, if the crop accumulates the heavy metals within limit (FAO/WHO Codex alimentation). Methi performed better with WW low nitrogen dose i,e N_{10} and $FA_{10.}$ Methi being a leguminous crop and is capable of nitrogen fixation therefore, not surprisingly that with low nitrogen dose it performed better. The symbiotic association could not enhanced the yield under high nitrogen (Ozanne 1980) but it is also worth to be noted that this treatment $N_{10}P_{15}K_{10}FA_{10}WW$ performed all over best suggesting that low nitrogen dose with two byproducts (WW and FA) can replace inorganic fertilizers and also chlorophyll content, protein content being associated with green pigment (Kulik et al. 1995) were high because these parameters need nitrogen which may be supplied by wastewater (Hussain et al. 2001). Leaf area was enhanced with low dose of nitrogen with WW and FA. Thus $N_{10}P_{15}K_{10}FA_{10}WW$ not only increase leaf area but may have enhanced photosynthetic rate. Nitrogen has well established role in cell division, expansion and differentiation and also in biochemical reactions (Gardner et al. 1985). This enhancement at low dose of nitrogen may be thus due to the presence of essential elements like N, Mg and K in WW. The presence of Mg^{++}ion in wastewater could have played an essential role in enhancing chlorophyll content and the photosynthetic rate in methi as Mg is central atom of chlorophyll which is required for structural integrity of chloroplast (Moorbyand Besford 1983). Similarly Ca^{++}an essential component of cell wall is involved in the cell division and is present in WW. It could have also acted to be beneficial for crop. Similarly essential micronutrients have played their essential role. When WW is applied, it becomes available to plants at critical stages of growth and is incorporated readily into protein and enzymes.

In addition to WW, FA application @ 10 t/ha have also shown significant results in comparison to control @ 5 t/ha. FA also contains essential nutrients except nitrogen and methi being leguminous crop show a symbiotic nitrogen fixation. Regarding the nodulation, treatment $N_{10}P_{15}K_{10}FA_{10}WW$ proved better as compared to control (Figure 2,f).

Low nitrogen dose proved better for nodulation at all the sampling stages. It has been established that nodulation and N_2 fixation activity in legumes and plants are strongly inhibited by high level of nitrogen (Streeter 1988). The inhibitory effect of exogenous nitrate in N_2 fixation has variously been attributed to a direct competition between nitrate reductase and nitrogenase for reducing power (Stephens and Neyra 1983, Vassileva and Ignatov 1996) or to the fact that nitrate a product of NR inhibits the function of leghaemoglobins (Becana and Sprent 1987).For heavy metal leaves were analyzed for lead and chromium and it was observed that these two heavy metals were present within the permissible limits.

It was concluded that with two wastes byproducts WW and FA methi a leguminous crop can be grown along with low inorganic fertilizers dose especially nitrogen.

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